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(71) Applicants
The British Petroleum Company p.l.c.

(Incorporated in United Kingdom)

Britannic House, Moor Lane, London EC2Y 9BU.

Seanor Engineering A.S.

(Incorporated in Norway)

Nedre Strandgate 9, N–3000 Drammen, Norway

(72) Inventor
Birger Vaage

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(74) Agent and/or Address for Service
M MacLeod,
BP International Limited, Patents & Agreements Division,
Chertsey Road, Sunbury-on-Thames, Middlesex
TW16 7LN

(54) Pig launcher

(57) A launcher is described suitable for inserting a number of pigs eg. four in sequence into subsea pipelines, particularly in deep water in diverless operations.

The multi-shot pig launcher comprises a pig launcher module A containing a plurality of pig storage chambers 1 and a rotatable, barrel selector 42, and a saver sub module B for connection to a pipeline.

Oil poured through kick lines 11 from a manifold 12, kick lines 23 and a well drive a pig, when required, from its chamber 1. The launcher is lowered on a running tool via a connector 6. The latter is also used for connection to a R.O.V. when in place. Shock absorbers 17 are employed to cushion the landing of the modules A and B.

FIG. 1.

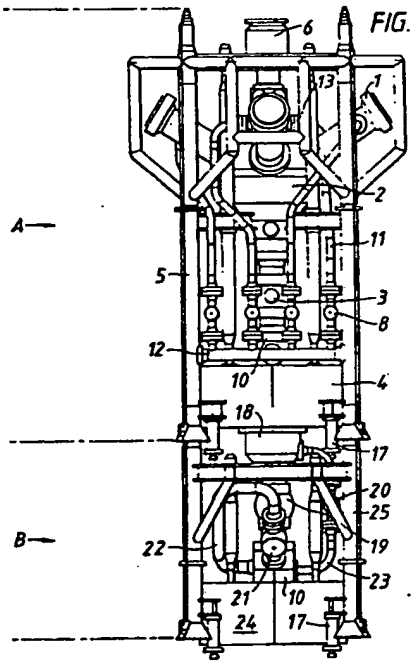

FIG. 5.

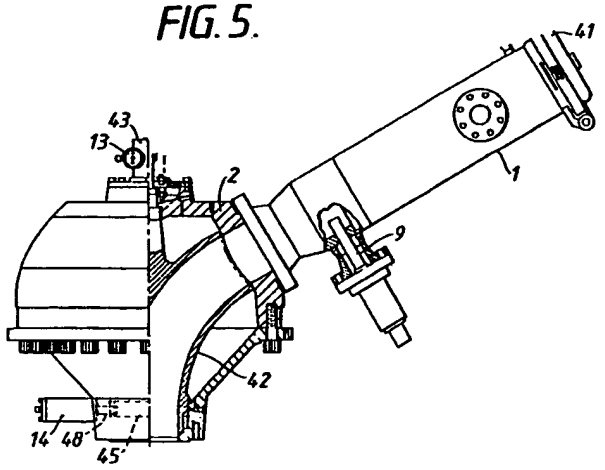

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FIG. 1.

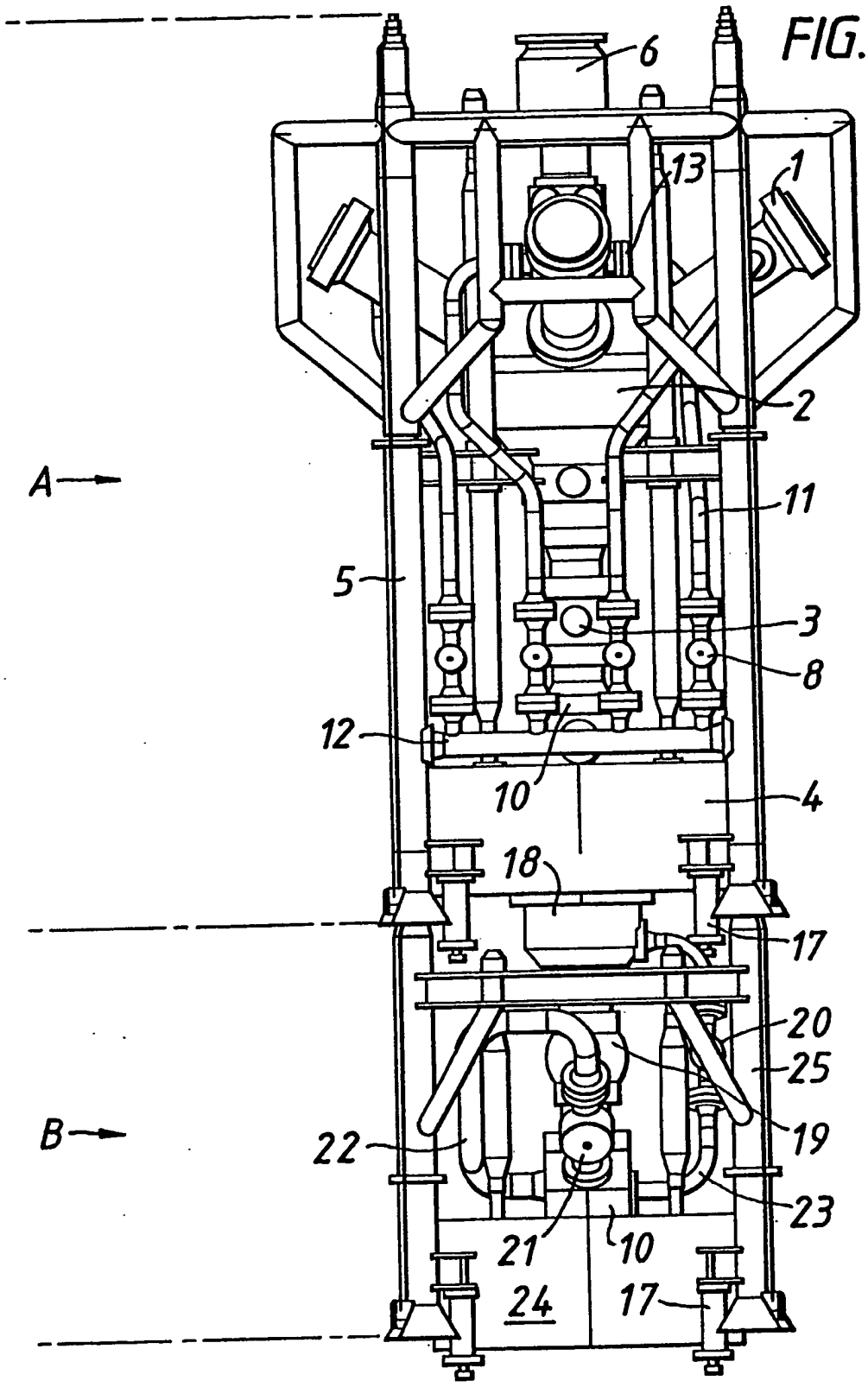

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FIG.2.

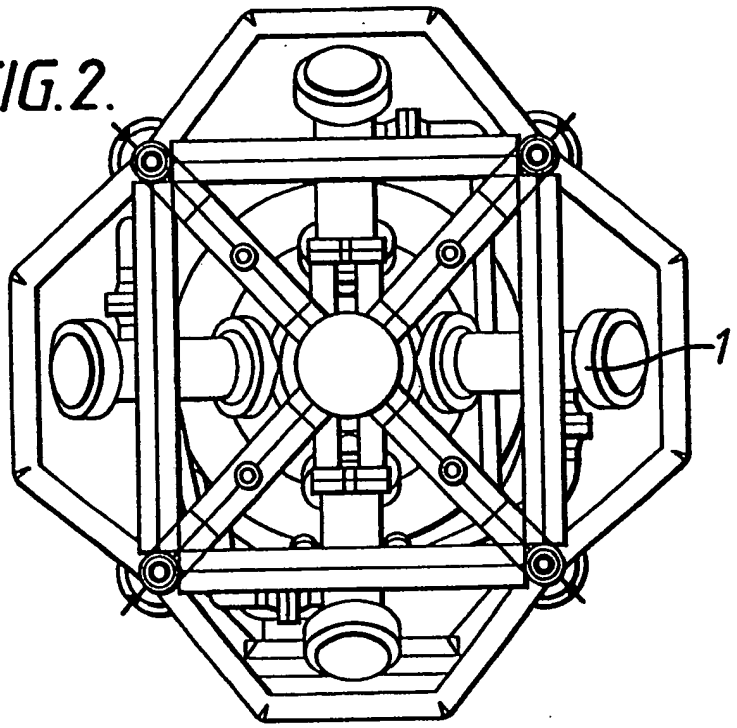


FIG.6.

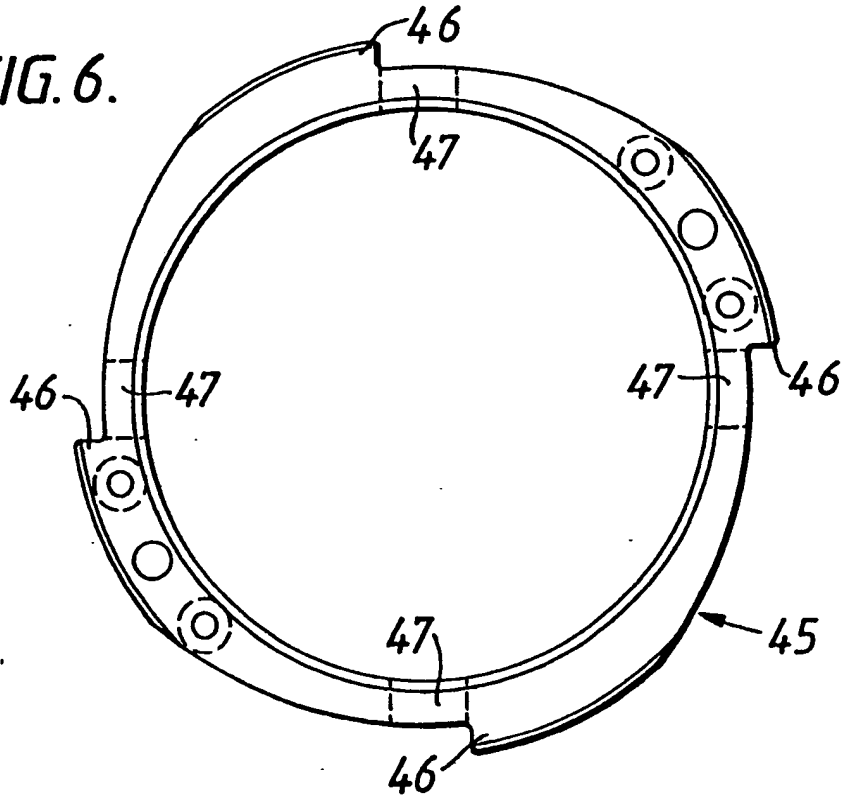


FIG. 3.

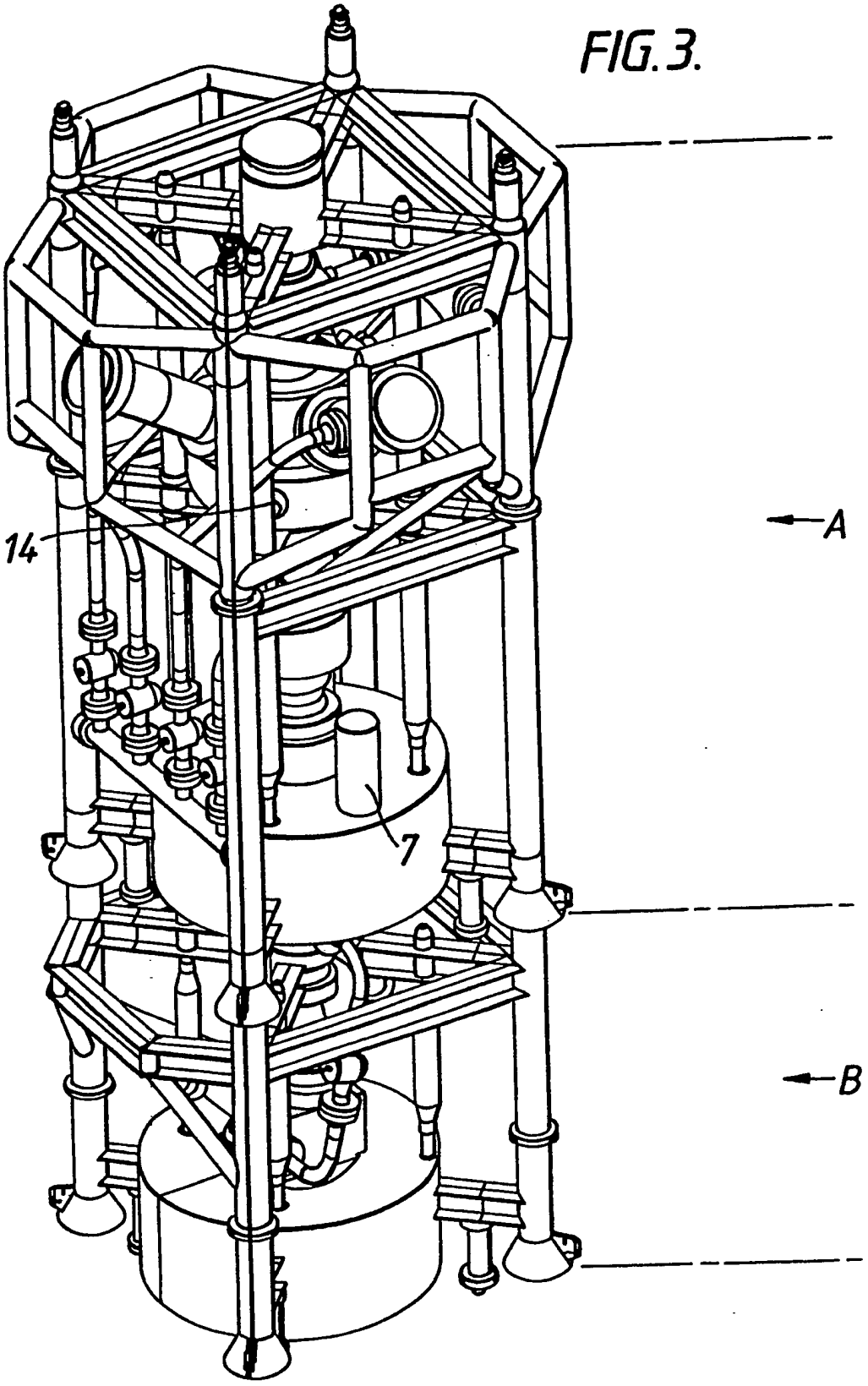
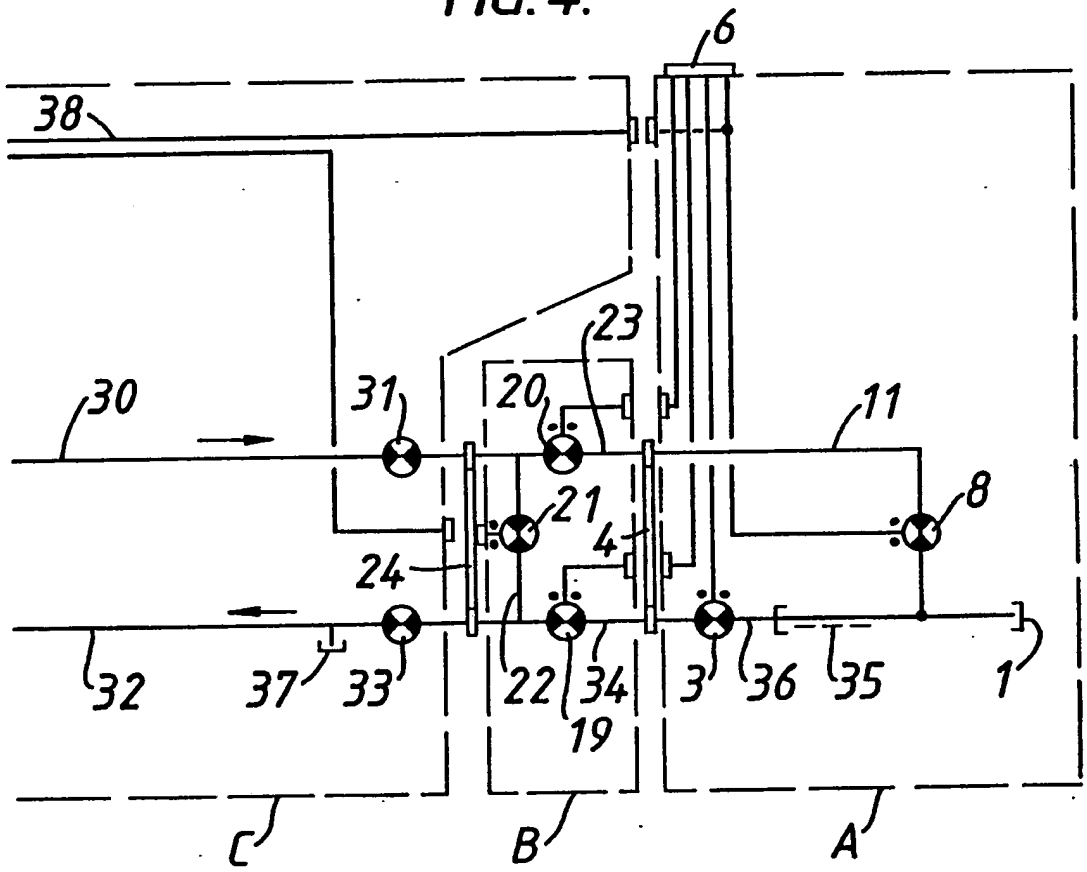


FIG. 4.



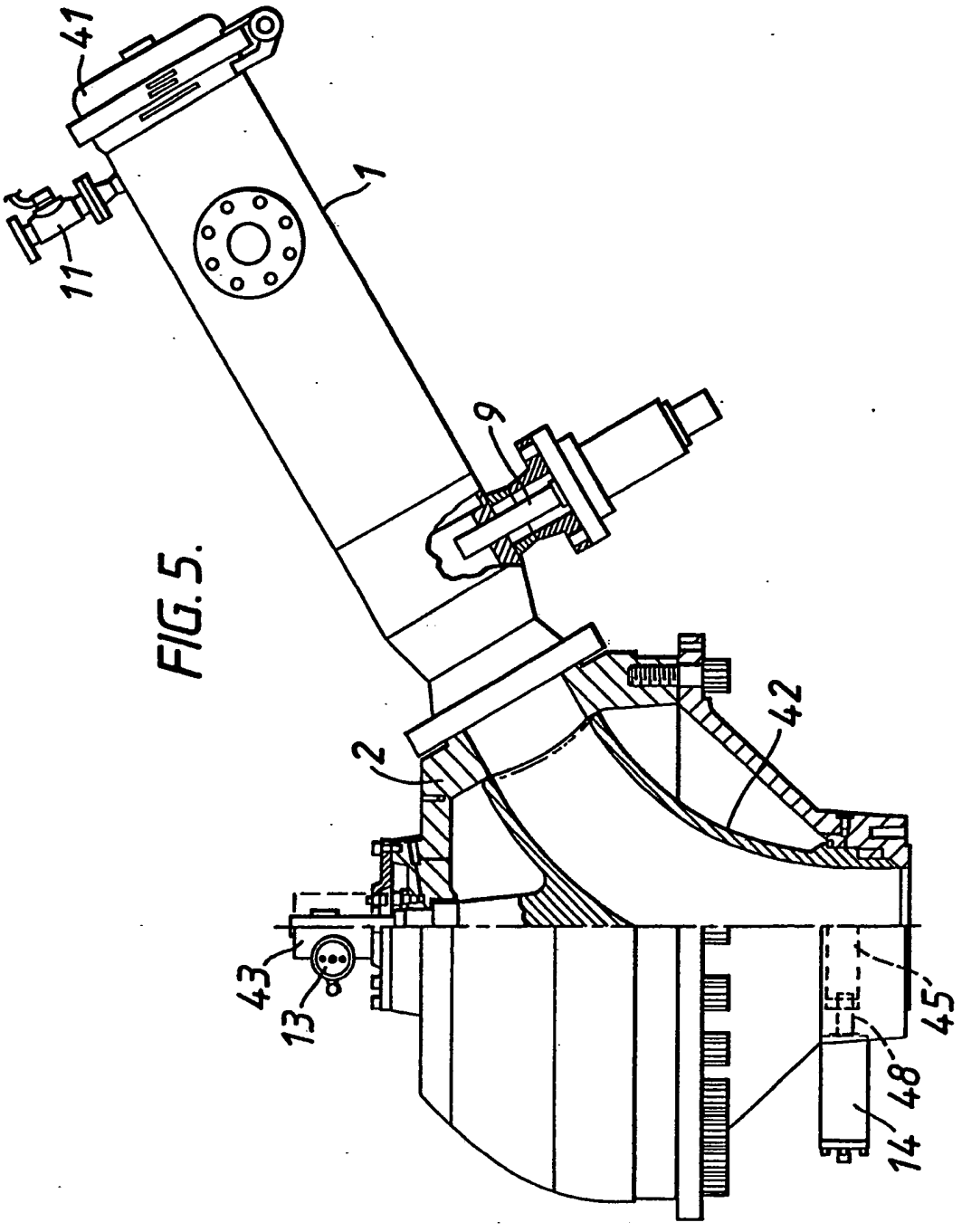


FIG. 5.

SPECIFICATION

Pipelin pig launcher

This invention relates to apparatus for inserting a pig into a subsea pipeline, particularly in deep waters.

A considerable proportion of the world's remaining oil reserves is believed to lie offshore under depths in excess of 200 metres, in relatively small oil fields, and in hostile environments. As any one of these conditions intensifies, and more particularly when two or more are present together, the cost of conventional offshore recovery systems wherein drilling and production facilities are mounted on the deck of free standing platforms rises rapidly and soon becomes uneconomic.

For this reason attention has been given to subsea systems where a favoured technique is to drill a number of locational wells close together and to mount the well head control equipment on the sea bed. In order to do this, a structure known as a template is employed. In essence this is a large frame with guide tubes for drilling which is deposited on the sea bed in a desired location. After drilling, well head completion and production equipment are mounted on the frame and these facilities remain on the sea bed.

Although remotely operated vehicles (ROVs) are also known for inspecting, testing and servicing the production systems, water depths, up until now, have nearly all been such that the systems have been accessible to divers.

As the water depths in which oil is found and produced increase, totally diverless systems will be needed. Even in shallower depths, however, diverless systems could be economically attractive. It may also be necessary or desirable to dispense with guidelines, depending on the depth of the water.

Oil produced from such systems is transported by subsea pipelines either to on- or offshore facilities where it is treated for gas and water removal before being dispatched to refineries for further processing.

Production from single subsea wells or groups of wells associated with a template is delivered to the treatment facilities by pipelines of relatively small diameter known as flowlines. When the treatment facilities are on an offshore platform, total production is combined on the platform and exported after treatment by means of a large diameter pipeline known as the main oil line.

After the construction f a pip line it is necessary t clean it out before use, for example, to remove rust, scale, sand and other c ntaminants. During use, deposits may form on the internal surface and, if not removed, th se may build up and reduce the capacity of the pip line.

For these duties, it is stablished practice to force a tightly fitting obj ct known as a pig through the pipeline by xerting fluid pressure b hind it.

Pigs may be of various configurations, depending on their intend d functions. They may be cylindrical or spherical in shape.

Cylindrical pigs are frequently fitted with brushes and/or scrapers and are used for removing deposits such as wax which form on the internal surface of the pipeline. Such pigs are also fitted with cup-like washers which form a seal against the pipeline.

Spherical pigs are generally hollow, inflatable globes made from elastomeric material which are inflated with liquid to a diameter slightly exceeding the diameter of the pipeline so that they make a tight fit with the pipeline wall. They roll and turn in an unpredictable manner as they travel through the line. Spherical pigs are usually used for initial cleaning operations, for maintenance of gas lines (and also for product separation in liquid lines, although this duty is unlikely to be required in subsea flowlines).

Pigs are inserted into and recovered from pipelines by devices known as pig launchers and pig receivers. They are generally inserted into the lines from single shot pig launchers mounted on surface facilities, and recovered in a similar way. Access for pig insertion and maintenance is readily available. Such pig launchers are not suitable for use in diverless subsea systems.

We have now devised a multi-shot pig launcher suitable for use in pigging flowlines in diverless subsea operations.

Thus according to the present invention there is provided a multi-shot pig launcher comprising

(1) a pig launcher module and (2) a saver-sub module, the pig launcher module comprising

(a) an upper connector for lowering or lifting by a running tool,

(b) a housing containing a plurality of pig inlets, a single pig outlet, a selector for connecting any desired inlet to the outlet and actuating mechanism for the selector,

(c) a plurality of pig storage chambers, each chamber being connected to a pig inlet of the housing, and

(d) means for applying pressure to each storage chamber whereby the pig stored therein is released and forced into and through the selector mechanism and out of the outlet,

(e) an inlet from and an outlet to the saver-sub module, and

(f) a lower connector for connection to the saver-sub modul , the saver-sub module comprising

(g) an upper connector for c nnection to the pig launcher module,

(h) an inlet from and an outlet to the pig launch r module,

(i) an inl t from and an utlet to the production line to be pigged,

(j) a lower connector for connection t the

production line t be pigged, and

(k) control valves and piping to permit oil to flow from a well thr ugh th saver-sub module directly to the production line or alternatively from the well through the saver sub-module, through the pig launcher module and back through the saver sub-module to the production line to provide the means for applying pressure to the pig storage chambers and the means for entry of the pig into the production line.

The saver-sub module may be connected to the production line either vertically or horizontally.

The connectors between the pig launcher module and the saver-sub module and between the latter and the production line are preferably of the collet type and may be operated by a mechanism comprising push rods activated by hydraulic jacks in a running tool.

The selector is preferably the bore of a rotatable barrel. Most preferably the bore is curved to permit offset entry of a pig and vertical exit. Alternatively, a Y-type configuration may be employed.

The actuating mechanism for the selector may comprise a pinion on a rotatable shaft connected to the selector, the pinion being driven by a hydraulically operated rack.

A locking mechanism is preferably provided to lock the selector in position when a pig is about to be launched. This may take the form of a cam ring, the number of cams on the ring corresponding to the number of pig storage chambers. Four will usually be a convenient number. Preferably an aperture for a locking pin is provided in the cam ring immediately before the shoulder of each cam.

Each pig storage chamber is preferably fitted with a pig locking mechanism, e.g. a hydraulically operated valve or locking pin.

Both modules may be surrounded by guide frames.

The pig launcher module is normally purged with sea water as it is lowered subsea by the running tool. When this is to be the case, a vent is provided.

The running tool will be deployed from a service riser, control cable and handling system.

The pig launcher will normally be used in association with a multi-well sub-sea template. Production from the wells will be manifolded to surface treatment facilities where the pigs will be recovered for re-use.

In order to deploy and use th pig launcher module the following sequenc of operations takes place:

—The pigs ar inserted into the launcher on the surface, and the pig launcher module is attached to a running tool and lowered to the subsea producti n system.

—The launcher module is connected to a saver-sub module which is connected to the manifold of the subsea production system.

—The saver-sub modul contains isolation valves and is retrieved only in the event of damage f the connect r to the launcher module, or in case of isolation valve failure.

—Pigs are selected for launch and launched by remote control via the template control system.

—The pig launcher is retrieved for reloading when all pigs are launched.

The invention is illustrated with reference to Figures 1 to 6 of the accompanying drawings wherein Figure 1 is an elevation of a 4-shot pig launcher and Figures 2 and 3 are plan and isometric views respectively. Figure 4 is a simplified schematic flow line drawing, Figure 5 is an elevation, partly in section of a pig launching module and Figure 6 is a plan of the selector locking mechanism.

With reference to Figures 1 to 3, the pig launcher comprises a pig launcher module A and a saver-sub module B coupled together by means of a collet connector 4.

The pig launcher module A contains four offset pig storage chambers 1 fitted with pig lock assemblies, each connected to a pig selector housing 2 containing a rotating barrel selector rotated by an actuator 13 and locked in position by a lock assembly 14. The outlet from the selector housing 2 is controlled by a main launcher valve 3. Further downstresm, a pig sensor 10 is provided to detect the launching of a pig.

The pig launcher module A also contains a kick system to pass oil through a pig storage chamber 1 and entrain a pig when the appropriate lock assembly 14 is released. The kick system comprises a kick manifold 12 which is supplied with produced oil from the saver-sub module as subsequently described. The kick manifold 12 feeds four kick lines 11, one leading to each pig storage chamber 1. Each kick line is controlled by a kick valve 8.

The saver-sub module B comprises a collet connector 24 for connection to the manifold of a subsea production template, a pig launcher hub 18 communicating with the outlet from the pig launcher module A and, between them, a pig isolation valve 19 controlling the outlet to the production manifold.

Oil from the template manifold enters the saver-sub module B through the connector 24.

A bypass valve 21 is provided in the saver-sub module B. When the bypass valve 21 is closed, flow is diverted to the kick system of the pig launcher module by way f kick line 23 and isolati n valve 20, which feeds the kick manifold 12 of the pig launcher module through the connector 4.

The pig launcher module A is surrounded by a guide frame 5 and the saver-sub m dule B by a guide frame 25. Frame 5 is joined to a hub 6 f r c nnecti n to a running tool. Both guide frames 5 and 25 are fitted with shock absorbers 17 to provide soft landing on the saver-sub module and the t mplat respec-

tively. Control of the modules is effected through a control pod 7.

With referenc to Figure 4, thre modules are shown in block form, the pig launcher module A, the saver-sub module B and the template manifold module C.

Oil is taken from module C by way of test header 30 and flows through test header isolation valve 31 and into module B through the connector 24. Module C also contains the production header 32 and production header isolation valve 33.

Module B contains the bypass valve 21, bypass line 22, kick line 23, kick line isolation valve 20, pig line 34, and pig line isolation valve 19.

When isolation valves 20 and 19 are closed and bypass valve 21 is opened, oil flows from the test header 30 through the bypass line 22 and returns to the production header 32 without entering module A.

Oil may be alternatively taken from the test header through the kick line 23 and through the connector 4 into the pig launcher module A.

To simplify Figure 4, the kick manifold 12 is omitted from the drawing, and a single kick line 11 controlled by kick valve 8 is shown in module A connecting with the kick line 23 in module B. Kick line 11 enters the pig storage chamber 1 behind the pig 35. A pig line 36 emerges from the storage chamber 1 controlled by the main launcher valve 3 and is connected through the connector 4 with pig line 34 in saver-sub module B.

When bypass valve 21 is closed and isolation valves 20, 3 and 19 and kick valve 8 are open and the pig locking mechanism is released, oil flows through kick lines 23 and 11 and into the pig storage chamber 1 where it flushes the pig 35 into the pig lines 36 and 34 and into and through the production header 32. A detector 37 emits a signal when the pig passes it.

The valves and controls are operated via an umbilical control line 38. The connector hub for an ROV or running tool is shown st 6.

With reference to Figures 5 and 6, the pig launcher module comprises four offset pig storage chambers 1. Each is fitted with an end cap 41 and a hydraulically operated locking pin 9 to hold a pig in position.

Each chamber communicates with the pig selector housing 2 which contains a rotating curved barrel selector 42 mounted on an actuating shaft 43. The shaft 43 is fitted with a pinion which is rotated by a hydraulically driven rack 13 to align the barrel 42 with any desired storag chamb r 1. Th barrel 42 is fitted near its base with a lockable cam ring 45 shown in more detail in Figure 6.

The cam ring 45 contains four cams 46. At the should r of each cam 46 is an aperture 47 for ngagem nt with the locking pin 48 of the hydraulically operated selector lock assembly 14.

When the locking pin 9 is released, the pig is forced out of the pig chamber 1 by oil entering the chamb r 1 behind the pig by way of kick line 11.

The procedure for rotating the barrel to a selected position is as follows:

a) The rotor is initially locked in one of its four locked positions (position i).

b) The control system determines whether the newly selected position (j) has a higher or lower number than i.

c) Hydraulic pressure is supplied to the rotor-lock cylinder.

d) The lock-pin is pushed out of the hole in the cam, and the rotor is unlocked.

(If the selected rotor position is higher than the initial position (j greater than i), then the procedure continues from point e2.)

e1) Hydraulic pressure is supplied to the actuator for rotating the rotor counter clockwise.

f1) The actuator rotates the rotor counter clockwise.

g1) The hydraulic supply to the actuator is shut-off when the rotor has rotated 45' past the desired position.

h1) The rotor stops in this position.

k1) The hydraulic supply to the rotor lock-cylinder is shut-off, and the pressure is bled off.

l1) The pressure in the launcher and the spring in the lock cylinder will force the lock-pin against the cam on the rotor.

(Force: 0.7-3.2 kN).

m1) Hydraulic pressure is supplied to the actuator to rotate the rotor clockwise.

n1) The cam on the rotor will stop against the lock-pin after the rotor has rotated spproximately 45'.

p1) The hydraulic pressure to the actuator is shut-off, and the fluid on both sides of the actuator piston is connected to allow the piston to "float".

q1) The pressure in the launcher and the spring in the lock cylinder will force the lock-pin into the hole in the cam, and lock the rotor against rotation, in both directions.

The procedure ends when j is less than i, i.e. when the selected position is lower than the initial position.

For j greater than i, i.e. when the selected position is higher than the initial position:

e2) Hydraulic pressure is supplied to the actuator for rotating the rotor clockwise.

f2) The actuator rotates the rotor clockwise.

g2) The hydraulic supply to the rotor lock-cylinder is shut-off, and the pressur is bled off, when th r tor is 45° from the desired position.

h2) as l1.

k2) As n1.

l1) As p1.

m2) As q1.

The procedure ends when j is greater than i, i.e. when the selected position is higher than

the initial position.

CLAIMS

1. A multi-shot pig launcher comprising (1) a pig launcher module and (2) a saver-sub module, the pig launcher module comprising

(a) an upper connector for lowering or lifting by a running tool,

(b) a housing containing a plurality of pig inlets, a single pig outlet, a selector for connecting any desired inlet to the outlet and actuating mechanism for the selector,

(c) a plurality of pig storage chambers, each chamber being connected to a pig inlet of the housing, and

(d) means for applying pressure to each storage chamber whereby the pig stored therein is released and forced into and through the selector mechanism and out of the outlet,

(e) an inlet from and an outlet to the saver-sub module, and

(f) a lower connector for connection to the saver-sub module, the saver-sub module comprising

(g) an upper connector for connection to the pig launcher module,

(h) an inlet from and an outlet to the pig launcher module,

(i) an inlet from and an outlet to the production line to be pigged,

(j) a lower connector for connection to the production line to be pigged, and

(k) control valves and piping to permit oil to flow from a well through the saver-sub module directly to the production line or alternatively from the well through the saver-sub module, through the pig launcher module and back through the saver-sub module to the production line to provide the means for applying pressure to the pig storage chambers and the means for entry of the pig into the production line.

2. A pig launcher according to claim 1 wherein the selector is the bore of a rotatable barrel.

3. A pig launcher according to claim 2 wherein the bore is curved to permit offset entry of a pig and vertical exit.

4. A pig launcher according to any of the preceding claims comprising a locking mechanism to lock the selector in position when a pig is about to be launched.

5. A pig launcher according to any of the preceding claims wherein each pig storage chamber is fitted with a pig locking mechanism.

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